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Early and Midterm Outcomes of Rheumatic Mitral Valve Repair

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ABSTRACT

Background: Rheumatic heart disease (RHD) is the leading cause of mitral valve disease in the developing world. In general, mitral valve repair is preferred over replacement. Although it is very successful in degenerative disease, its results in the rheumatic valve are not as successful as that for degenerative repair. Our approach has been to repair rheumatic mitral valves when the anatomic substrate appears to permit it, and we aimed by this study to present our immediate and midterm follow-ups of our cohort of rheumatic valve repair patients.

Methods: From February 2011 to March 2013, 52 consecutive patients underwent mitral valve repair for rheumatic disease with different surgical techniques at the National Heart Institute of Egypt. Patients who had concomitant aortic or coronary artery bypass surgery were excluded. Also, patients needing an emergency operation or redo ones were excluded. On the contrary, patients who had concomitant tricuspid valve surgery were included. Demographic, intraoperative, and perioperative outcome data were recorded prospectively. All patients underwent TTE before hospital discharge. During follow-up, patients were contacted by telephone and invited for follow-up TTE yearly after their operations.

Results: Fifty-two patients with rheumatic disease underwent mitral repair. Their mean age was 25.92 ± 9.81 years. The study population was 78.8% female. Forty-nine patients were in New York Heart Association functional class III or IV. Repair procedures included implantation of Carpentier-Edwards Classic mitral annuloplasty ring (100% of the whole study group). Mitral commissurotomy and repair of the subvalvular apparatus were generally performed. Thirteen neochordae were implanted. Anterior leaflet extension with an autologous pericardial patch was used in 4 patients; annular decalcification, in 2 patients; tricuspid repair with De Vega technique, in 18 patients (34.5%); and repair with Carpentier-Edwards Classic tricuspid annuloplasty ring, in 9 (17.3%) patients. There was no operative mortality. The mean follow-up time was 59.9 ± 5 postoperative months (range, 49-60 months). Only 2 patients (3.8%) died. Follow-up echocardiography revealed more-than-or-equal-to-moderate (2+) grade of MR in 5 patients. During the follow-up period, the mean LV end-diastolic diameter decreased significantly from 5.57 ± 1.06 cm to 4.93 ± 0.74 cm (<0.001). The mean pulmonary artery pressure decreased from 44.94 ± 17.01 mmHg to 35.69 ± 7.92 mmHg postoperatively ($P < .001$). The mean mitral valve area increased from 1.2 ± 0.9 cm^2 to 2.3 ± 0.2 cm^2 postoperatively ($P < .001$). The mean mitral valve gradient decreased significantly from 12 ± 4.9 mmHg to 4.3 ± 1.9 mmHg postoperatively ($P < .001$). The mean MR grade decreased from 3.73 ± 0.45 to 0.96 ± 1.08 postoperatively ($P < .001$).

Conclusion: We conclude that repair is possible in patients with rheumatic mitral valve dysfunction. Current techniques with some modifications can be efficient to restore both the anatomy and physiology (better function) of the mitral valve and can lead to favorable early and midterm outcomes. We, therefore, recommend that the number of rheumatic mitral repair procedures should be increased in developing countries to achieve the best results.

INTRODUCTION

Rheumatic heart disease (RHD) is the leading cause of mitral valve disease in the developing world. It is the most severe sequela of rheumatic fever and occurs in approximately 30% of patients with rheumatic fever [Rheumatic . . . 2004]. Mechanical mitral valve replacement has its possible complications [Enriquez-Sarano 1995]. Mitral valve repair in general not only avoids these complications but also permits growth and preserves left ventricular (LV) geometry and function; although mitral valve repair in RHD is technically demanding [Erez 2003], it is very successful in degenerative mitral valve disease, is associated with low operative mortality and morbidity rates, and has excellent late survival, freedom from reoperation, and freedom from thromboembolic complications [David 1998]. Nevertheless, the appropriateness of valve repair for patients with rheumatic mitral valve disease, even when repair appears to be technically feasible, remains controversial [Grossi 1998]. Our approach has been to repair rheumatic mitral valves when the anatomic substrate appears to permit it, and we aimed by this study to present our immediate and midterm outcomes of our repaired rheumatic mitral valve patients.

PATIENTS AND METHODS

From February 2011 to March 2013, 52 consecutive patients underwent mitral valve repair for rheumatic disease with different surgical techniques at the National Heart Institute of Egypt. Patients who had concomitant aortic or coronary artery bypass surgery were excluded. Also, patients needing an emergency operation or redo ones were excluded. On contrary, patients who had concomitant tricuspid valve

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surgery were included. For patients who had isolated mitral stenosis, there is a tendency to replace the mitral valve because the Wilkins score is usually above 8 or they were associated with aortic valve disease. Hence, they were excluded. Demographic, intraoperative, and perioperative outcome data were recorded prospectively.

Preoperative Clinical and Echocardiographic Assessment

The decision to repair the mitral valve was taken on the basis of preoperative transthoracic echocardiography (TTE). The degree of mitral regurgitation (MR) was graded on the basis of regurgitant volume and effective regurgitant orifice area, and mitral stenosis (MS) was graded on the basis of measuring the mitral valve area and the mean pressure gradient. In addition, all patients had intraoperative transesophageal echocardiography (TEE) to analyze the valve before and after the valve repair. This includes assessment of mitral annulus, leaflet thickness and mobility, commissural and chordal fusion, calcification, regurgitation jets, the thickness of the chordae tendineae, left atrial (LA) thrombus, and other valvular lesions. Again, postoperative predischarge TTE, as well as the midterm follow-up TTE, was done for all patients, and follow-up was 100% complete. Documentation of pre- and postoperative atrial fibrillation and New York Heart Association (NYHA) class was routinely performed.

Surgical Technique

The surgical approach was done via median sternotomy, central cannulation, and cardiopulmonary bypass (CPB) with systemic cooling to moderate hypothermia (32°C). Then myocardial protection was achieved by the administration of antegrade intermittent cold blood cardioplegic solution, as well as topical ice slush. The mitral valve was exposed through an incision behind the interatrial groove.

Depending on the valve morphology encountered, a combination of techniques was used including annuloplasty, commissurotomy, chordal shortening, cusp augmentation, cuspal thinning, cleft suture, decalcification, splitting of the papillary muscles or chordae fenestration, and neochordae construction with Gore-Tex® sutures (W. L. Gore & Associates, Inc., Newark, DE, USA).

Anterior leaflet extension with pericardial patching was performed in 4 patients who had restricted anterior mitral leaflet. An incision was made over the leaflet parallel and immediately next to the mitral annulus to detach the leaflet, leaving most of the leaflet with the chordae attached. Then the gap of a patch of the autologous freshly prepared pericardium of appropriate size was sutured to the gap created so as to augment and reconstruct the anterior leaflet. After valve repair, usually, not only the anatomic shape of the mitral valve is restored (the anterior leaflet occupied three quarters of the mitral valve orifice, and the posterior leaflet occupied one quarter), but also the physiological performance. This is evidenced by better mobility, an increase of valve area, and better coaptation. Moreover, decalcification of calcified leaflets or annulus and removal of thickened valve tissue were performed, if required. In this study, decalcification of annulus was done for a couple of cases with removal of some foci only of calcified annulus without total disruption or detachment of the leaflet tissue.

As far as the ring is concerned, in the mitral position, a Carpentier-Edwards Classic mitral annuloplasty ring (Edwards Lifesciences Corp., Irvine, CA, USA) was generally used in the presence of grade 3 to 4 MR or residual regurgitation after mitral commissurotomy. The size of the ring was selected in accordance with the intercommissural distance and/or the height measurement of the anterior mitral leaflet. After the completion of repair, mitral valve competence was tested by injecting a cold saline solution into the LV cavity. TEE was used to evaluate the result intraoperatively.

After the evacuation of LA thrombus if any, obliteration of the appendage was performed by closing the appendage from the inside with a double running Prolene 4-0 suture (Ethicon, www.ethicon.com) and double pieces of Teflon felt. If the diameter of the tricuspid valve annulus was above 40 mm and/or there was +2 or more tricuspid regurgitation (TR) on TTE preoperatively, repair with Carpentier-Edwards Classic tricuspid annuloplasty ring (Edwards Lifesciences Corp.) or suture-based De Vega repair was performed. In this study, tricuspid repair with De Vega technique was performed in the beating heart after the conclusion of rheumatic mitral repair and removal of the cross-clamp, whereas tricuspid valve repair with Edwards Classic tricuspid annuloplasty ring was performed with the cross-clamp still applied after the conclusion of the mitral repair procedure.

Follow-up

All patients underwent TTE before hospital discharge. During follow-up, patients were contacted by telephone and invited for follow-up TTE yearly after their operations. All TTEs during follow-up visits were performed at our institution. Clinical data recorded during the follow-up period included death after surgery, atrial fibrillation, need for reoperation, MR recurrence, thromboembolism, and postoperative endocarditis. All patients were maintained on anticoagulation with warfarin sodium for 3 months after surgery, and permanently if they had atrial fibrillation.

Statistical Analysis

Recorded data were analyzed using the IBM SPSS Statistics for Windows, Version 20.0 (released 2011; IBM Corp., Armonk, NY). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Paired-sample t test of significance was used in comparison of related samples.
- Chi-square (χ^2) test of significance was used to compare proportions between 2 qualitative parameters.
- The confidence interval was set to 95%, and the margin of error accepted was set to 5%. So, the *P* value was considered significant/insignificant according to the following:
- *P* value ≤ .05 was considered significant;
- *P* value ≤ .001 was considered as highly significant;
- *P* value > .05 was considered insignificant.

Table 1. Preoperative Baseline Characteristics of the Study Group*

Demographic Data	n (%) or Range (Mean ± SD) (N = 52)
Sex	
Female	41 (78.8%)
Male	11 (21.2%)
Age (years)	16-40 (25.92 ± 9.81)
Preoperative NYHA	
2	3 (5.8%)
3	34 (65.4%)
4	15 (28.8%)
Pathology of mitral valve	
MR	32 (61.5%)
Mixed MR and MS	20 (38.5%)
MR grade	3-4 (3.73 ± 0.45)
Preoperative echocardiography	
LVEDD (cm)	4-8.2 (5.57 ± 1.06)
LVESD (cm)	2.3-6 (3.61 ± 1.00)
LA (cm)	3.1-8.3 (5.04 ± 1.41)
RV (cm)	1.6-2.9 (2.20 ± 0.41)
Pulmonary hypertension (mmHg)	23-82 (44.94 ± 17.01)
EF (%)	41-77 (63.25 ± 8.50)
Concomitant pathology	
Moderate TR	7 (13.5%)
Severe TR	20 (38.5%)
Preoperative atrial fibrillation	15 (28.8%)

* NYHA, New York Heart Association; MR, mitral regurgitation; MS, mitral stenosis; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LA, left atrial; RV, right ventricular; EF, ejection fraction; TR, tricuspid regurgitation.

RESULTS

Demographic Criteria

Preoperative patient characteristics are shown in Table 1. The mean age was 25.92 ± 9.81 years (range, 16-40 years). The study population was 78.8% females because we were so keen on giving the young rheumatic females in the childbearing period the best option of avoiding anticoagulants, giving them a durable repair, decreasing the number of redo operations and avoiding all complications of mitral valve replacement. Most of the study group (49 patients) had NYHA class ≥3. The presenting lesions of the rheumatic mitral valve were pure MR in 32 patients (61.5%) and mixed stenosis and regurgitation in 20 patients (38.5%). MR grade mean was 3.73 ± 0.45. Atrial fibrillation was documented in 15 patients (28.8%). Seven cases had moderate TR and 20 cases of severe TR as a concomitant pathology. The mean of LV end-diastolic dimension of this cohort was 5.57 ± 1.06 cm, LA size was 5.04 ± 1.41 cm, right ventricular (RV) size was 2.20 ± 0.41 cm, LV ejection fraction (EF) was 63.25% ± 8.50%, and pulmonary hypertension was 44.94 ± 17.01 mmHg.

Table 2. Operative Data of the Study Group* <<Q14>>

Operative Data	n (%) or Range (Mean ± SD) (N = 52)
CPB (min)	3-110 (80.92 ± 9.91)
X-clamp (min)	33-70 (49.12 ± 9.34)
Op time (min)	125-187 (145.65 ± 10.91)
Commissural fusion	20 (38.5%)
Leaflet thickening	29 (55.8%)
Restricted leaflet	18 (34.6%)
Chordal retraction	20 (38.5%)
Mitral annular dilatation	43 (82.7%)
LA thrombus	2 (3.8%)
Anterior leaflet prolapse	10 (19.2%)
Posterior leaflet prolapse	7 (13.5%)
Chordal elongation	13 (25.0%)
Mitral annular calcification	7 (13.5%)
Tricuspid annular dilatation	22 (42.3%)
Fenestration	16 (30.8%)
Anterior leaflet augmentation	4 (7.7%)

*CPB, cardiopulmonary bypass time; op time, total operative time; X-clamp, cross-clamp time.; LA, left atrial.

Operative Data

Operative details of the patients are presented in Table 2. The pathological lesions encountered in the mitral and tricuspid valves intraoperatively were commissural fusion (38.5%), thickened leaflets (55.8%), decreased leaflet mobility (34.6%), and mitral annular dilation (82.7%), and they were the most common conditions. Leaflet prolapse (32.7%), elongation or rupture of chordae (25.0%), and mitral annular calcification (7.7%) were also observed. Tricuspid annular dilation was present in 22 patients (42.3%).

There was no operative death. All patients had mild, trivial, or no MR on intraoperative TEE examination after repair. Mitral ring annuloplasty using Carpentier-Edwards Classic mitral ring was performed in all patients (100%), and the mean ring size was 30.5 ± 2.1 mm. Mitral commissurotomy and repair of the subvalvular apparatus were generally performed. Thirteen neochordae were implanted: 10 chordae were implanted in the anterior leaflet and 3 in the posterior leaflet. Anterior leaflet extension with an autologous pericardial patch was performed in 4 patients with severe rheumatic restriction and retraction of the anterior mitral valve leaflet. Annular decalcification was performed in 2 patients. Tricuspid repair with De Vega technique was performed in 18 patients (34.5%); and repair with Carpentier-Edwards Classic tricuspid annuloplasty ring, in 9 (17.3%) patients.

Table 3. Immediate Postoperative Outcome of the Study Group*

Early Postop Follow-up	n (%) or Range (Mean ± SD) (N = 52)
Mechanical ventilation	5-14 (8.60 ± 2.32)
Intensive care unit stay (d)	1-5 (2.38 ± 1.11)
Hospital stay (d)	6-13 (7.81 ± 1.67)
Prolonged inotropic use	12 (23.1%)
Acute renal failure	3 (5.8%)
Permanent pacemaker needed	2 (3.8%)
Bleeding	6 (11.5%)
Tamponade	2 (3.8%)
Superficial wound infection	3 (5.8%)
Deep wound infection	1 (1.9%)

Immediate Postoperative Outcome

Immediate postoperative outcome is portrayed in Table 3. The mean of mechanical ventilation time was 8.60 ± 2.32 hours; the lengths of stay in the intensive care unit and hospital were 2.38 ± 1.11 days and 7.81 ± 1.67 days, respectively. Prolonged delivery of inotropic agents (>24 hours) was needed in 12 patients (23.1%). Acute renal failure (creatinine level, >1.5 mg/dL) developed in 3 patients (5.8%); none of them needed dialysis. Pacemaker implantation was performed in 2 patients (3.8%) with postoperative complete heart block. There was no procedure-related postoperative morbidity such as thromboembolism or early reoperation.

Midterm Follow-up

Table 4 depicts the clinical and echographic midterm follow-up of the study group. The mean follow-up time was 59.9 ± 5 postoperative months (range, 49-60 months). Only 2 patients (3.8%) died. The first patient had mitral repair and concomitant tricuspid valve repair (De Vega repair) and had been readmitted 10 months later because of a low cardiac output (pump failure) and died. The second one developed early endocarditis on readmission 6 months after hospital discharge and died.

The assessment of the repair performance is presented in Table 5, in which the comparison between the baseline clinical profile and echocardiography is done for the patients preoperatively and approximately 5 years postoperatively. In this table, we can appreciate the significant decrease of LV end-diastolic dimension, LV end-systolic dimension, RV dimension, pulmonary hypertension, MR grade, and NYHA class.

At hospital discharge, there was no residual moderate-to-severe MR. At the follow-up visits of the 50 surviving patients, more-than-or-equal-to-moderate (2+) grade of MR was diagnosed in 5 patients (Table 4), 2 of them underwent successful redo mitral valve replacement, and 3 of them had been offered conservative medical treatment and follow-up.

During the follow-up period, the mean LV EF decreased from 63.25% ± 8.50% to 61.02% ± 8.50% (P = .184). The mean LV end-diastolic diameter (LVEDD) decreased significantly from 5.57 ± 1.06 cm to 4.93 ± 0.74 cm (<0.001). The mean LV end-systolic diameter (LVESD) decreased from 3.61 ± 1.00 cm to 3.25 ± 0.61 cm (P < .001). The mean pulmonary artery pressure decreased from 44.94 ± 17.01 mmHg to 35.69 ± 7.92 mmHg postoperatively (P < .001) (Table 5). The mean mitral valve area increased from 1.2 ± 0.9 cm^2 to 2.3 ± 0.2 cm^2 postoperatively (P < .001). The mean mitral valve gradient decreased significantly from 12 ± 4.9 mmHg to 4.3 ± 1.9 mmHg postoperatively (P < .001). The mean MR grade decreased from 3.73 ± 0.45 to 0.96 ± 1.08 postoperatively (P < .001).

Table 4. Clinical and Echographic Midterm Follow-up of the Study Group*

Midterm Follow-up	n (%) or Range (Mean ± SD) (N = 52)
LVEDD (cm)	3.8-6.5 (4.93 ± 0.74)
LVESD (cm)	2.4-5.4 (3.25 ± 0.61)
RV (cm)	1.2-3 (1.97 ± 0.53)
LA (cm)	3.6-8.3 (5.03 ± 1.28)
EF (%)	38-74 (61.02 ± 8.50)
TR	3 (5.7%)
Moderate	2 (3.8%)
Severe	1 (1.9%)
Pulmonary hypertension (mmHg)	25-55 (35.69 ± 7.92)
Postoperative NYHA	
1	38 (73.1%)
2	14 (26.9%)
Mortality, 5 Y	2 (3.8%)
Need for reoperation	3 (5.8%)
MR grade, 5 Y	0-4 (0.96 ± 1.08)
Atrial fibrillation, 5 Y	17 (32.7%)

*Y, year. See Table 1 footnote for expansion of other abbreviations.
<<Q15: For Table 4, confirm editing of the footnote; and confirm editing to "Mortality, 5 Y" and "MR grade, 5 Y" and "Atrial fibrillation, 5 Y".>>

COMMENT

Degenerative mitral valve pathology is by far the most common cause for MR in the industrialized world. In these cases, mitral valve repair is the procedure of choice, with excellent results [Espada 1998]. On the other hand, the rheumatic etiology of mitral valve disease is the most prevalent in developing countries and is associated with substantial morbidity and a tremendous health care expense [Bakir 2013]. Every effort should be exerted to repair mitral valve as a form of conservative treatment because a large proportion of rheumatic patients are young and therefore subject to a greater number of surgical operations during evolution [Pomerantzeff 1999].

<<Q16: Review the editing of the heads carefully; confirm, or indicate corrections.>>

Table 5. Assessment of Rheumatic Mitral Valve Repair Performance at Midterm*

Parameters	Preoperative mean ± SD (N = 52)	Postoperative mean ± SD (N = 50)	t or χ^2†	*P* value‡
Echocardiography				
LVEDD (cm)	5.57 ± 1.06	4.93 ± 0.74	6.806	< .001
LVESD (cm)	3.61 ± 1.00	3.25 ± 0.61	4.794	< .001
LA (cm)	5.04 ± 1.41	5.03 ± 1.28	0.076	.940
RV (cm)	2.20 ± 0.41	1.97 ± 0.53	–3.120	.003
Pulmonary hypertension (mmHg)	44.94 ± 17.01	35.69 ± 7.92	5.453	< .001
EF (%)	63.25 ± 8.50	61.02 ± 8.50	1.338	.184
NYHA				
1	0 (0%)	38 (73.1%)	94.118†	< .001
2	3 (5.8%)	14 (26.9%)		
3	34 (65.4%)	0 (0%)		
4	15 (28.8%)	0 (0%)		
Concomitant pathology				
≥ Moderate TR	27 (51.9%)	3 (5.8%)	6.58†	.016
Atrial fibrillation	15 (28.8%)	17 (32.7%)	0.048†	.827
MR grade	3.73 ± 0.45]	0.96 ± 1.08	16.897	< .001

*t, Paired t test; χ^2, chi-square test. See Table 1 footnote for expansion of other abbreviations.

†Numbers in this column with a dagger are χ^2 test results. The others are paired t test results.

‡*P* value ≤ .05 is significant, *P* value ≤ .001 is highly significant, and *P* value > .05 is insignificant. (Significant or highly significant *P* value are in bold.)

Surgical repair of rheumatic mitral valve disease is technically more demanding owing to the multiplicity of reasons such as the fibrotic process, involving the mitral valve and calcification of the mitral leaflets or annulus, which can diminish the likelihood of successful repair in rheumatic disease, even in experienced hands. Moreover, rheumatic mitral valve repair has a higher potential failure rate compared with repair of degenerative disease. However, many surgeons agree that mitral valve repair should be performed instead of replacement as a primary correction if possible [Suri 2006].

Even in the presence of less leaflet tissue and subvalvular fibrosis, mitral repair still can be the initial procedure of choice in rheumatic disease because it had shown better outcomes than mitral valve replacement [Shuhaiber 2007], bearing in mind that this outcome depends on the degree of impairment of the valve at the time of surgical correction, that is, the worse the condition at the time of surgical repair, the worse the outcome [Wang 2008]; moreover, follow-up had confirmed that if the initial repair is satisfactory and these patients are followed up regularly, good long-term results can be expected [Kumar 2006].

Our approach, therefore, has been to repair rheumatic mitral valves when the anatomic substrate encountered appears to permit it. In other words, preoperative and intraoperative echocardiographic examinations, as well as intraoperative inspection of the mitral valve, help to predict the suitability of mitral valve repair. The presence of minimal subvalvular lesions and pliable leaflets increases the likelihood of successful and durable mitral repair.

Commissural fusion is usually found in rheumatic mitral valves. They cause both stenotic and regurgitant components of mitral valve lesions owing to decreased valve area and restriction of leaflet mobility. In our series, 38.5% of patients presented with mixed stenotic and regurgitant lesions. Mitral repair is challenging in these cases because they require complex repair techniques. The majority of these patients in whom significant MR developed in the context of mixed lesions or LV dysfunction were independent predictors of valve failure according to some authors [Kumar 2006].

In this study, commissurotomy was performed to address fused commissures, and it was successful in treating commissural fusion that is not associated with severe chordal fusion or shortening. Whether to add a ring in this situation or not is subject to the presence or absence of mitral annulus dilatation; therefore, commissurotomy can be completed with ring annuloplasty to improve leaflet coaptation. As mentioned by Carpentier in the discussion section of Yau's article [Yau 2000], the main factors predicting reoperation in Yau's rheumatic series were annular dilation without the use of a ring on the initial operation (16%), the predominance of stenotic lesions (16%), leaflet retraction (32%), and leaflet prolapse

(32%). In this study, mitral ring annuloplasty was performed in almost all patients who needed commissurotomy.

Generally speaking, routine use of prosthetic-ring annuloplasty proved its efficacy both on a short- and long-term basis [Silberman 2009], and it decreases the rate of reoperations in the rheumatic population [Bernal 2010].

Carpentier-Edwards Classic mitral rings were used in our cohort to improve leaflet coaptation and to reduce the incidence of recurrent MR. Large rings (for example, 31 to 32 mm were used in men and 29 to 31 mm were used in women). To our knowledge, there is no consensus on which type of annuloplasty ring—flexible, semirigid, or rigid—is best in reducing MR in the context of rheumatic regurgitation, but larger rings are recommended in treating rheumatic mitral disease according to some authors [Silberman 2009]. Although rigid rings can have some problems, such as systolic anterior motion, according to some authors [Bakir 2013], we did not have any reported problems associated with their use in our cohort. The proponents of flexible rings have the view of better maintenance of variable dynamic geometry of the mitral valve by their use. Also, both early LV function and diastolic flow through the mitral valve during exercise can be improved, according to some reports in the literature [Okada 1995].

Neochordal implantation was used to correct leaflet prolapse and other complex valve situations including rheumatic lesions [Acar 2004; Gupta 2010]. In this particular subset (rheumatic lesions), indications for neochordal implantation include chordal fusion, retracted papillary muscles, chordal rupture, chordal elongation, and whenever adequate native chordae are not available. A freedom from reoperation rate of 82% to 94% at 10 years after Gore-Tex sutures use had been reported in some series [Acar 2004; Gupta 2010] However, the long-term results of chordal replacement in rheumatic disease are not clear. Chordal transfer, on the other hand, is not associated with good outcome when used in rheumatic valve repair. It is technically demanding, and when applied to a fibrotic rheumatic leaflet, results are guarded [Suri 2006].

In this series, 10 neochordae were implanted in the anterior leaflet position versus 3 in the posterior one. Gore-Tex sutures were placed between the tip of the papillary muscle and the free edge of the mitral leaflet. The level of the corresponding annulus was used as a reference point to adjust the length of them [Kim 2010]. Mild residual MR in TEE is the limit to accept the result of our repair and the limit beyond which revision of the repair should be performed or there should be conversion to the replacement of mitral valve, which had not been performed in our patients in this study.

Progressive rheumatic leaflets' fibrosis and subvalvular apparatus affection can lead to both leaflets' restriction and failure of coaptation. It has been reported that almost two thirds of rheumatic mitral posterior leaflets are restricted [Bernal 2010]. This can be associated with anterior leaflet prolapse due to chordal or papillary muscle elongation. To improve coaptation, augmentation of the retracted leaflets is recommended [Okada 1995; Acar 2004; Gupta 2010]. The use of autologous or heterologous patch material, rather than diseased leaflet tissue left in situ, is better in this context to avoid further expected rheumatic inflammatory episodes that can deteriorate valve performance [Suri 2006]. In our study, anterior leaflet augmentation was performed in 4 patients, with a very good outcome.

Echocardiographic examinations at 59.9 ± 5 postoperative months revealed more-than-or-equal-to-moderate (2+) grade of MR. This MR was diagnosed in 5 patients (9.6%); 2 (3.9%) of them underwent successful redo mitral valve replacement. Similarly, Kim and associates [Kim 2010] reported 16.7% of 115 patients who had rheumatic mitral repair showed significant MR (> grade 2) or moderate mitral stenosis (mitral valve area, 1.2-1.4 cm^2), but no severe stenosis (mitral valve area, <1 cm^2) at follow-up at 66 ± 38.6 months . Of note, they stated that most reoperation was needed in the first 6 months postoperatively and then declined [Kim 2010]. Although the long-term follow-up of our patients had not been done, we report the good results of successful mitral repair at midterm. This is very important in the setting of rheumatic valve disease because it is often progressive.

In this study, hospital mortality was 0%; that is exactly like Petrucci Jr et al [Petrucci Jr 1999], who reported this figure in a small group of 23 rheumatic patients who had mitral valve repair. It is also near to what had been reported by Pablo Maria, who reported hospital mortality of 0.9%. Of interest, the late mortality of 3.2% with a linear rate of 0.5% patient-years was also reported by Pablo Maria, and this was lower than that found in the literature [Petrucci Jr 1999; Kumar 2006].

As far as reoperation is concerned, we only had 3.9% rate of reoperation need in the study period which is still in agreement with what had been reported in the literature [Antunes 1987] and is higher when compared with patients with degenerative etiology [Brandão 2007]. Nevertheless, we expect a higher rate of reoperation later because the rheumatic etiology is progressive in nature and provocation of structural changes in the mitral valve apparatus is an ongoing process [Fernandez 1992].

In summary, our subset of rheumatic patients undergoing mitral repair showed a low rate of postoperative complications and very acceptable midterm results. Such outcomes are similar to those found in the literature [Chauvaud 1986].

Limitations

This is a small observational prospective nonrandomized study that was done on a small number of rheumatic patients, and the results as well as the conclusion of this study should be interpreted with caution and with consideration of the limited number of patients and limited follow-up. Also, not all aspects of the immediate postoperative outcome have been investigated; nor has quality of life been considered at midterm to assess patients' clinical condition and satisfaction.

CONCLUSION

We conclude that repair appears to be possible in patients with rheumatic mitral valve dysfunction. Current techniques with some modifications can be efficient to correct the pathology and restore the anatomy and lead to favorable early and midterm outcomes. We, therefore, recommend that the

number of mitral repair procedures should be increased in developing countries to achieve the best results.

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